Final Report

LIMITED ENERGY STUDY
BUILDINGS 750 AND 798

FORT RICHARDSON, ALASKA

Prepared for

U.S. ARMY ENGINEER DISTRICT, MOBILE
MOBILE, ALABAMA 36628

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LIST OF ABBREVIATIONS

AC	-	air conditioning
ACH	-	air changes per hour
AHU	-	air handling unit
ASHRAE	-	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
Btu	-	British thermal units
Btuh	-	Btu per hour
CCF	-	compressed cubic foot
cfm	-	cubic feet per minute
DPW	-	Department of Public Works
ECIP	-	Energy Conservation Investment Plan
ECO	-	Energy Conservation Opportunity
EMC	-	E M C Engineers, Inc.
F	-	Fahrenheit
FEMP	-	Federal Energy Management Program
FLA	-	full load amperes
ft	-	foot, feet
ft^2	-	square feet
gpm	-	gallons per minute
HID	-	high intensity discharge
HPS	-	high pressure sodium
hp	-	horsepower
hr	-	hour
HRU	-	heat recovery unit
HVAC	-	heating, ventilating, and air-conditioning
IR	-	infrared
KBtu	-	one thousand British thermal units
Klb	-	one thousand pounds
KSF	-	one thousand square feet
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hours, one thousand watt-hours

LCCA	-	Life Cycle Cost Analysis
MAU	-	makeup air unit
MCACES	-	Micro Computer-Aided Cost Engineering System
MER	-	mechanical equipment room
R-value	-	the resistance of heat flow expressed in units of sq ft x hrs x °F/Btu; R-value = 1/U-value
rpm	-	revolutions per minute
SF	-	square foot, feet
SIR	-	Savings to Investment Ratio: total life-cycle benefits divided by 90% of the differential investment cost
SOW	-	scope of work
SPV	-	single present value factor
SZ	-	single zone
temp.	-	temperature
UA	-	overall heat transfer coefficient (Btu/hr·°F)
UPV	-	uniform present value factor
UV	-	ultraviolet
V	-	volts
yr	-	year(s)

EXECUTIVE SUMMARY

AUTHORITY

This study was performed and this report prepared under Contract No. DACA01-94-D-0033, Delivery Order No. 11. The delivery order was issued by U.S. Army Engineer District, Mobile, to E M C Engineers, Inc. on 15 September 1995.

PURPOSE

The purpose of this study is to identify and evaluate Energy Conservation Opportunities (ECOs) for two motor pool facilities, Buildings 750 and 798, to determine their energy savings potential, economic feasibility, and to document results for possible future funding.

METHOD OF ANALYSIS

The analysis proceeded as follows:

- Buildings 750 and 798 were surveyed and as-built drawings were collected to determine the present use, construction, occupancy patterns, lighting, equipment, and HVAC systems in both buildings.

- The existing conditions were simulated through the use of computer models. These models, referred to as the baseline models, were produced using the DOE2.1d building energy simulation program.

- The annual energy use results from the baseline computer models were compared to the available historical energy use data. This was done as a means of verifying the accuracy of the baselines.

- Potential ECOs were identified and evaluated individually. ECO evaluation included determining energy savings with the building energy simulation model, estimating construction costs, and performing a Life Cycle Cost Analysis (LCCA). Calculation of life cycle cost of each ECO was performed according to the guidance of the Energy Conservation Investment Program (ECIP).

- The ECOs which were identified to be cost effective were combined and analyzed together as one combined ECO. This is necessary to account for the synergistic effects the individual ECOs have on each other.

- The results of the baseline energy analysis and the ECO evaluations are summarized in this report. Recommendations were made based on economic factors and the

ability of the system, modified with the ECO, to maintain a comfortable environment.

- Programming documentation and supporting information for funding purposes was prepared and is presented in appendix G.

BASELINE ENERGY USE

Buildings 750 and 798 are heated by steam supplied from a central plant. The central plant uses natural gas as a primary fuel source to produce steam for both heating and electrical energy generation. Since power is produced on the base there is not a demand charge for electrical energy.

The utility rates were given as $0.0633/KWH ($18.55/MBtu) for electricity and $7.0693/klb ($5.276/MBtu) for steam. The cost of natural gas varies as a function of the quantity consumed. Two ECOs examined the use of natural gas in conjunction with steam as a method of heating the buildings. In these instances, the cost of natural gas was approximately $0.29/CCF ($2.84/MBtu).

Annual baseline energy consumption and cost data for each building is presented in Table ES-1. The combined energy costs for these two motor pools is approximately $175,000 per year.

The heating system in Building 750 was found to be severely under capacity. This is the result of the disabling of the under-floor heating system and the roof top MAUs. Building 798 also has had the under-floor heating system disabled. However, baseline simulations show that the remaining system is capable of maintaining thermostat setpoints during all but the coldest days of a typical year.

Table ES-1. Baseline Energy Consumption

Building No.	Utility Type	Baseline Usage (MBtu/yr)	Building Area (ft^2)	Baseline (MBtu/ft^2·yr)	Baseline ($/yr)
750	Electric	1,071.69	24600	0.044	$19,880
750	Steam	10,035.77	24600	0.408	$52,949
Subtotal					**$72,829**
798	Electric	1,670.45	39060	0.043	$30,987
798	Steam	13,516.36	39060	0.346	$71,312
Subtotal					**$102,299**
Total					**$175,128**

ENERGY CONSERVATION OPPORTUNITIES (ECOs)

The following is a brief summary of the ECOs investigated.

ECO 1: **Roof Insulation:** The installation of additional insulation to the inside surfaces of the roof was examined at two different thicknesses: R-19 and R-30.

ECO 2: **Wall Insulation:** The installation of additional insulation to the inside surfaces of the walls was examined at two different thicknesses: R-19 and R-30.

ECO 3: **Installation of New Windows:** The replacement of the existing windows with new heat reflecting, low heat conductance windows was examined.

ECO 4: **Infiltration Remediation:** The implementation of outside air infiltration remediation measures was examined.

ECO 5: **Door Insulation:** Installing additional insulation on the large overhead doors, and replacing the existing personnel doors with more insulating doors was examined.

ECO 6: **Controls Installation:** Some of the exhaust and make-up air units appear to be running during unoccupied periods. The installation of controls to shut off these units during these times was examined.

ECO 7: **Night Setback:** The existing system is controlled by nonprogrammable single setpoint thermostats. The installation of programmable, multiple setpoint thermostats was examined.

ECO 8: **Heat Recovery:** Currently, these buildings exhaust air from multiple locations throughout the buildings. Running ductwork from these exhaust locations to a central location and then through a packaged roof-top heat recovery unit was examined.

ECO 9: **Reduce Outside Air:** According to occupants surveyed, the exhaust systems in these buildings are inadequate or underutilized. Occupants often open the doors to reduce the level of engine exhaust in the building. The installation of a ventilation system would reduce the amount of outside air introduced through these open doors. A ventilation system which utilizes heat recovery was examined.

ECO 10: **High Efficiency Motors:** Replacing select motors in these buildings with high efficiency motors was examined.

ECO 11: **Radiant Heating:** The feasibility of installing two types of radiant heating systems was examined: These systems consisted of an under-floor hot water heating system and overhead gas-fired infrared heating system.

ECO 12: **High Efficiency Lighting:** Replacing and retrofitting the existing lighting systems in Building 798 was examined.

ECO 13: **Recondition Existing HRUs:** Building 750 has a rooftop make-up air system with a heat recovery loop installed between its outside air intake and the personnel exhaust system. This system has been disabled and is no longer operative. In lieu of ECO 8, the reconditioning of this system was evaluated.

ECO 14: **Heat Recovery Loop:** Building 798 has a large make-up air unit which brings in 100% outside air. This unit is intended to replenish some of the air that is being removed from the building by the exhaust systems. The installation of a run-a-round propylene glycol based heat recovery loop between the make-up air and a portion of the exhaust air systems was evaluated.

Table ES-2 below presents the results of the analysis for each ECO. The table is sorted in descending order based on the discounted SIR for each ECO.

Table ES-2. Summary of Results

ECO	Description	Electric Savings ($/yr)	Steam Savings ($/yr)	Natural Gas Savings/Cost ($/yr)	Total Energy Savings ($/yr)	Total Installed Cost ($)	Simple Payback (yrs)	Dis-counted SIR
7	Night Setback	$5,360	$34,673	N/A	$40,033	$16,401	0.41	23.10
6	Controls	$1,211	$13,637	N/A	$14,849	$6,366	0.43	22.20
4	Infiltration	$1,655	$14,699	N/A	$16,354	$47,316	2.89	6.30
11b	Radiant Heat (Gas)	N/A	$85,848	($40,078)	$45,770	$194,524	4.25	4.37
13	Recond. Exist. HRUs	($2,225)	$18,828	($12,156)	$4,447	$16,186	3.64	3.75
14	Heat Recovery Loop	$299	$2,627	N/A	$2,926	$25,470	8.71	2.09
10	High Eff. Motors	$483	N/A	N/A	$483	$4,629	9.60	1.57
9	Control Outside Air	$1,339	$15,031	N/A	$16,370	$377,065	23.03	0.79
11a	Radiant Heat (Floor)	$9,178	$26,594	N/A	$35,773	$870,376	24.33	0.73
5	Insulate Doors	$30	$438	N/A	$468	$11,952	25.53	0.72
1a	Roof Insul. (R-19)	$615	$6,180	N/A	$6,796	$206,502	30.39	0.60
12	High Eff. Lighting	$752	($291)	N/A	$461	$15,644	19.85	0.56
2a	Wall Insul. (R-19)	$437	$7,115	N/A	$7,552	$269,828	35.73	0.51
8	Heat Recovery	$810	$8,183	N/A	$8,993	$326,427	36.30	0.50
2b	Wall Insul. (R-30)	$522	$7,759	N/A	$8,281	$321,795	38.86	0.47
3	Windows	$328	$3,866	N/A	$4,193	$257,280	61.35	0.30
1b	Roof Insul. (R-30)	$712	$7,083	N/A	$7,794	$623,573	80.00	0.23
	Combined ECOs	$3,372	$105,173	($23,927)	$84,619	$310,892	3.67	4.83

A graphical representation of the annual energy use for the baseline models and each of the ECOs is presented in Figures ES-1 and ES-2 below.

Figure ES- 1. Steam & Gas Energy Use for Baseline and Examined ECO Modifications

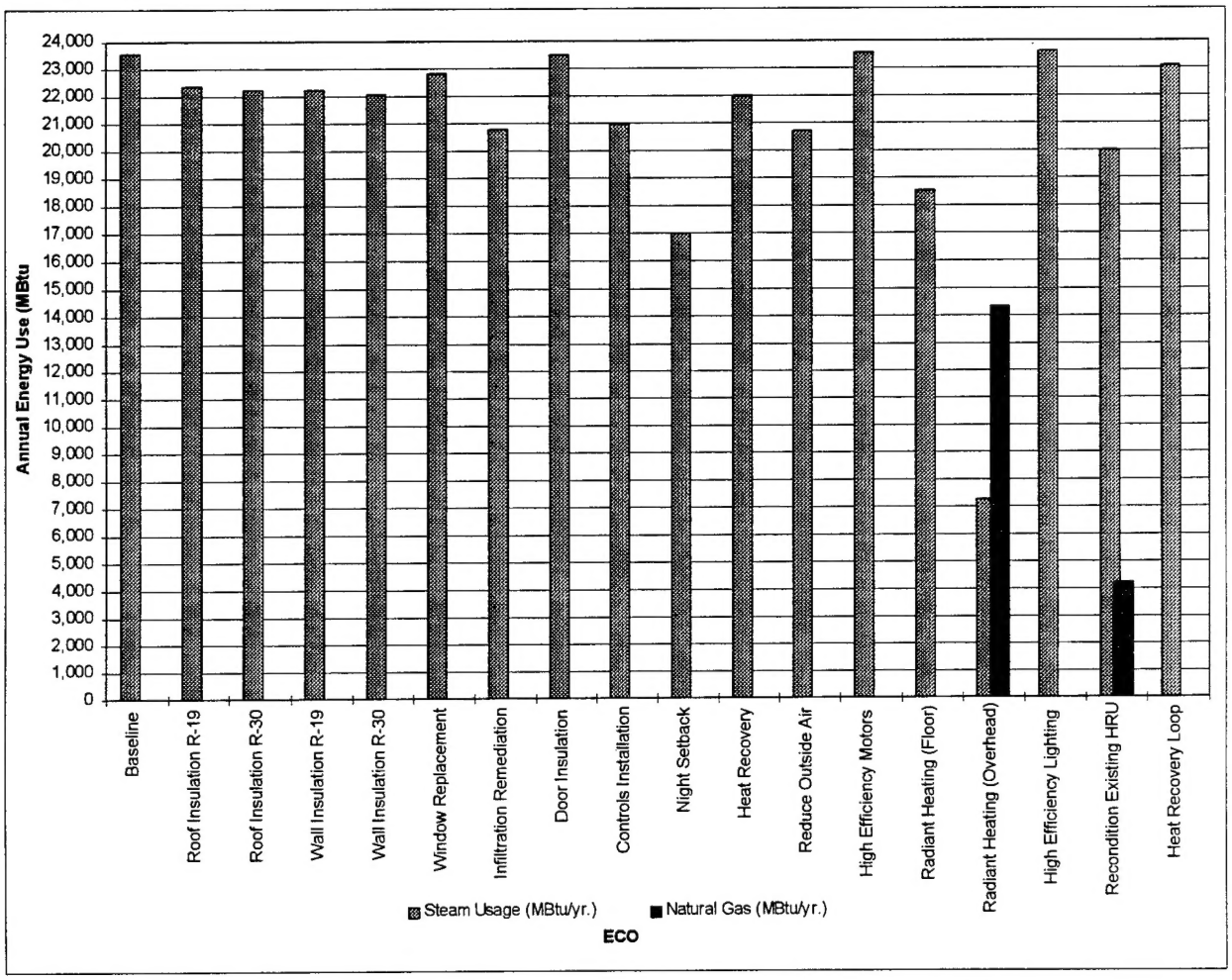
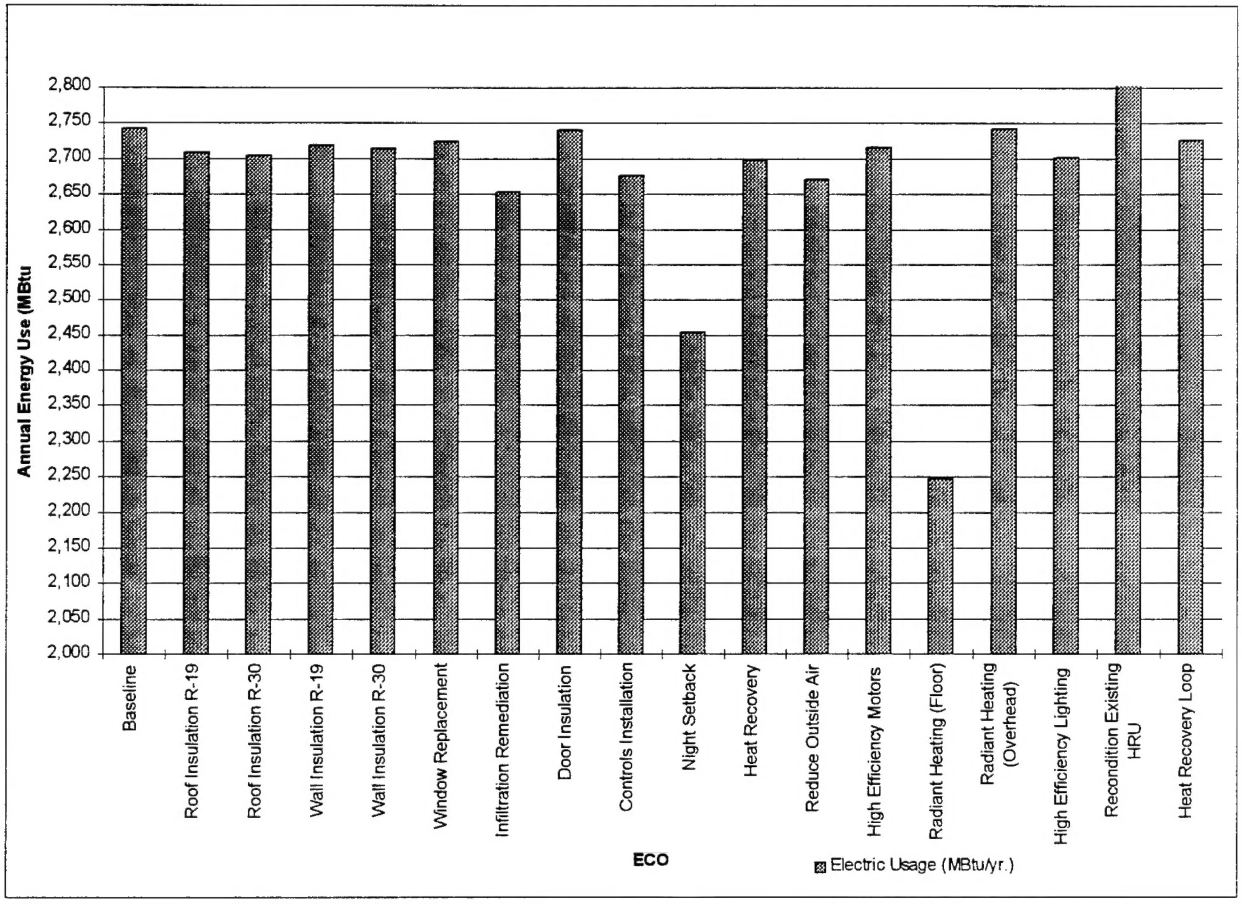


Figure ES- 2. Electric Energy Use for Baseline and Examined ECO Modifications



RECOMMENDATIONS

To qualify for government funding, ECOs must have a discounted Savings to Investment Ratio (SIR) greater than 1.25 and a simple payback less than 10 years. Qualified projects with investment costs less than $300,000 will qualify for the Federal Energy Management Program (FEMP). A qualified project with an investment cost greater than $300,000 can qualify for the Energy Conservation Investment Plan (ECIP) or FEMP funding. Table ES-3 on the following page presents the ECOs recommended for implementation.

Table ES-3. Summary of Recommended ECOs

ECO	Applied to Bldg.	Description	Electric Savings ($/yr)	Steam Savings ($/yr)	Natural Gas Savings/Cost ($/yr)	Total Energy Savings ($/yr)	Total Installed Cost ($)	Simple Payback (yrs)	Dis-counted SIR
7	Both	Night Setback	$5,360	$34,673	N/A	$40,033	$16,401	0.41	23.10
6	798	Controls	$1,211	$13,637	N/A	$14,849	$6,366	0.43	22.20
4	Both	Infiltration	$1,655	$14,699	N/A	$16,354	$47,316	2.89	6.30
11b	Both	Radiant Heat (Gas)	N/A	$85,848	($40,078)	$45,770	$194,524	4.25	4.37
13	750	Recond. Exist. HRUs	($2,225)	$18,828	($12,156)	$4,447	$16,186	3.64	3.75
14	798	Heat Recovery Loop	$299	$2,627	N/A	$2,926	$25,470	8.71	2.09
10	Both	High Eff. Motors	$483	N/A	N/A	$483	$4,629	9.60	1.57
		Combined ECOs	$3,372	$105,173	($23,927)	$84,619	$310,892	3.67	4.83
Combined MBTU Savings			182	19,934	(8,425)	11,691			

In addition to saving significantly on annual energy costs the installation of an overhead gas-fired infrared heating system (ECO 11b) would solving the heating capacity problems in these buildings. For these reasons, it is highly recommended.

Due to the pressurization and infiltration problems in Building 750, it is also highly recommended that the existing rooftop make-up air unit (MAU) with heat recovery be reconditioned and brought back on line (ECO 13). This would improve the comfort level of the occupants, increase the capacity of the building, and result in a savings on the annual energy costs.

As a result of the remote location and extreme weather in Alaska, material and labor costs are generally more expensive than in the remaining part of the continental United States. Alaska is also very rich in energy resources which makes the cost of energy relatively inexpensive. When these two factors are combined, the result is that many ECOs that traditionally pay well in other parts of the country are not economically feasible in this location.

The following ECOs were not found to be cost effective:

Table ES-4. ECOs Not Recommended

ECO	Description	Electric Savings ($/yr)	Steam Savings ($/yr)	Natural Gas Savings/Cost ($/yr)	Total Energy Savings ($/yr)	Total Installed Cost ($)	Simple Payback (yrs)	Dis-counted SIR
9	Control Outside Air	$1,339	$15,031	N/A	$16,370	$377,065	23.03	0.79
11a	Radiant Heat (Floor)	$9,178	$26,594	N/A	$35,773	$870,376	24.33	0.73
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1b	Roof Insul. (R-30)	$712	$7,083	N/A	$7,794	$623,573	80.00	0.23